WATER QUALITY

Beneficial Use Attainment

All streams classified for beneficial uses within the Bourbeuse River watershed are designated as suitable for warm-water aquatic life protection and fishing, and livestock and wildlife watering. Additionally, 14.5 miles of Brush Creek from the mouth to the dam at Indian Lake are designated as whole body contact and recreation. The Bourbeuse River is classified as a Class P stream, meaning the stream maintains permanent flow even during drought periods, for the first 132.0 miles from the mouth to the headwaters (MDNR 1994). Stream uses for this segment include: irrigation, livestock and wildlife watering, warm-water aquatic life protection and fishing, cool-water fishing, whole-body contact recreation, boating and canoeing, and drinking-water supply. Nine miles of the Bourbeuse River's 147 total miles may cease flow during dry periods; therefore, it is classified as a Class C stream. Stream uses for this segment include: livestock and wildlife watering, warm-water aquatic life protection and fishing, and cool-water fishing. Of the River's 147 total miles, the remaining six miles of the Bourbeuse River are unclassified stream.

Threats to Beneficial Uses

Non-attainment of whole-body recreational use and drinking-water supply could result from failure of sewage lagoons. The Union waste water treatment lagoon has in the past caused high levels of fecal coliform in receiving waters. In 1996, the Missouri Department of Natural Resources (MDNR) reported no adverse impact from the Union lagoon; however, some filamentous algae was observed (MDNR 1996). Also, the City of Sullivan discharges treated water to Winsel Creek. The City of Sullivan and the MDNR have struggled with the recent designation of portions of Winsel Creek as a losing stream and with the collapse potential of the city's treatment lagoon resting on karst bedrock (Sullivan Independent 1996). Though beneficial uses are being maintained both cases, the potential exists for groundwater contamination that could impair the drinking-water supply from such sources.

Current threats to beneficial uses are excessive discharge from sewage treatment plants (STP), cattle in streams causing water quality problems, and lastly. Several STPs have problems that need to be addressed. Robinson Creek, in the upper Bourbeuse River watershed, receives flow from the St. James STP. In a 1995 survey, the MDNR found sludge, grease, and excessive algae in Robinson Creek (MDNR 1996). Biological oxygen demand (BOD) and nonfilterable residues (NFRs) in receiving waters of waste-water treatment plants should not exceed a monthly average of 30 mg/l and weekly average of 45 mg/l (MDNR 1984). St. Clair waste-water treatment facility (WWTF) was surveyed in March 1996 and had a BOD=30 mg/l and NFRs=128 mg/l (MDNR 1996). The Cuba WWTF discharges into Pleasant Valley Creek – BOD and NFRs are higher than permitted. Excessive use of Bourbeuse River watershed streams for watering cattle may be more of a problem than it is for the Meramec River watershed, given the large amount of pasture in the Bourbeuse River watershed. Lastly, atrazine is an agricultural pesticide used to control weeds and certain grasses. In 1993, the maximum contaminant level for atrazine in public drinking water was established at 0.003 milligrams per liter. Atrazine levels in the Bourbeuse River are much lower than the water quality standard for the maximum contaminant level (Buchanan 1995).

Water Quality

The MDNR is responsible for regulating water quality in the state of Missouri. Its mission is to ensure

that the quality and quantity of the water resources of the state are maintained to support existing and potential beneficial uses. Some aspects of their mission are shared with the Missouri Department of Conservation.

Compared with the Meramec River, the Bourbeuse River has poorly sustained base flows during dry periods except below Spring Creek that is fed by Kratz Spring (MDNR 1984). Also, compared with the Meramec River, the Bourbeuse River is more turbid and prone to algae blooms.

Potential sources of pollutants come from 1) Cuba, affecting Brush Creek, 2) Bland and Belle, affecting Dry Fork, 3) Owensville, affecting Red Oak Creek, 4) Sullivan, affecting Spring Creek, and 5) Union, affecting the lower Bourbeuse River. In 1964, the Missouri Water Pollution Board sampled several of these streams for indicator aquatic invertebrates. Invertebrate species, suggesting good water quality, were found on Brush Creek, Dry Fork, Bourbeuse River near Chouteau Claim, Bourbeuse River near Noser Mill, Bourbeuse River headwaters, and Boone Creek. Red Oak Creek was suspected to be contaminated by heavy metals from a plating plant at Owensville (MDNR 1964). Although indicator algal cultures showed that organic pollution was present at several Bourbeuse River sites that were receiving waste water, water quality was good. In a 1978 survey by the Department of Conservation, the presence of excessive aquatic plant growth indicated that organic pollutants had degraded water quality on several miles of tributaries (Red Oak Creek, Happy Sock Creek, Pin Oak Creek) and main stem reaches (Duchrow 1978).

Springs

Springs in the Bourbeuse River watershed are not as numerous as the Meramec River watershed. Four sizable springs are on the west side of the fault that runs parallel to Highway 19 (Table 9). Kratz Spring, the largest spring in the watershed, surfaces on the eastern side of the Leasburg fault that intersects Spring Bluff township and ends east of Beaufort. The presence of Pennsylvanian age rock and Jefferson City Dolomite likely prevents water movement to subsurface levels, explaining the lack of springs in the watershed. The Roubidoux and the Gasconade formations are permeable to water. Kratz Spring is found in the Gasconade Formation.

Chemical Quality of Stream Flow

The Bourbeuse River flows over younger geologic formations than surrounding watersheds, and this characteristic influences its water chemistry. The chemical composition of the Bourbeuse is affected by erosion, surface runoff, and to a lesser degree, municipal and industrial effluents. Erosion and surface runoff are influenced by soil permeability (Table 1).

Selected water quality parameters (USGS 1995) for the Bourbeuse River watershed at the Union USGS gage station (Figure 4) in Franklin County are compared with Missouri State Water Quality 1995 Standards within designated uses I, II, VI, and VII (Table 10). Fluoride levels did not exceed four mg/l as F (USGS 1995). Surface water pH over the thirty-year period from 1964 to 1994 did not fall outside the state standard range of 6.5-9.0. Surveys of stream pH during habitat assessment, however, indicated that pH at some sites was out of state standard range. The pH levels are affected by photosynthesis and fluctuate daily. Nitrogen nitrate (mg/l N) never exceeded the state limit (Table 10). Fecal coliform levels, however, exceeded the whole-body contact limit during part of 1984 and 1996. The sewage treatment plant at Union may contribute to high fecal coliform levels. In 1964, no samples for coliform bacteria from any station had colonies greater than 100 per 100 ml except during periods of high runoff (MDNR

Table 9. Location and discharge of springs into the Bourbeuse River watershed. Rate of flow represents records for dates ranging from 1924-72 (Vineyard and Feder 1982).

Spring	Nearest Town/County	Twnshp-Rge-Sec	Rate of Flow	
			Cubic feet per second (CFS)	1,000 gallons/day
Kratz	Stanton/Franklin	41N-2W-4-SENW	15.6 42.0 6.85	10,100 27,100 4,430
Coon Cave	Bland/Gasconade	40N- 6W-14-NWNW	0.2	129
McDade	Cuba/Crawford	39N-5W-16-NENW	0.8 1.43 0.56 1.19	517 924 362 769
Mint	Redbird/ Gasconade	40N-6W-13-NESE	0.01	6 32
Rhodes	Bland/Gasconade	40N-6W-22-NENW	< 0.01	< 0.01

1964). Ammonia is an indicator of organic pollution and elevated pH reveals high concentrations of ammonium ions. The Union gage station had pH and ammonia concentrations (related measures) below toxicity levels. Levels of ammonia-N were less than 0.1 mg/l over the thirty-year period. This station is influenced by surface-water runoff from the urban environment and may not represent average conditions in the watershed.

Citizen groups, such as the Missouri Stream Team, are taking an increasing role in water-quality information collection. Stream Teams collect information mainly on water color, odor, and clarity.

.Other information collected includes: temperature, dissolved oxygen, pH, nitrates and ammonia, total dissolved solids (TDS), phosphate, zinc, lead, fecal coliform, and stream flow.

Fish Kills, Contamination Levels, and Health Advisories The Conservation Department has investigated reports of fish kills since the late 1940s. Pollution accounts for some fish kills found in Missouri waters, but many are caused by non-regulated conditions. The purpose of fish kill investigations is to detect the causes and to abate and mitigate for the losses to aquatic resources and recreation. Pollution causes are divided into categories as follows: transportation, industrial, municipal, agricultural, miscellaneous, and undetermined causes. Reports of these activities related to pollution and fish kills have been compiled into reports since the 1960s.

Pollution can result in contamination of state waters and aquatic species. To guard against the adverse effects of fish contamination to humans from fish consumption, the State of Missouri releases a health advisory. The Missouri Department of Health has no health advisories for fish in the Bourbeuse River watershed.

Fish Kills and Pollution Events

Pollution events in the Bourbeuse River watershed have resulted in few fish kills (Table 11). Only one in six of the events caused an immediate loss of fish. Flat Creek in Union lost an estimated 5,280 fish to an industrial pollutant in May of 1995. The remaining pollution events did not result in an immediate loss in fish. One pollution event was for Rhodamine dye, which is used by the MDNR to determine the path of subsurface water by injecting sinkholes. Two of the six reported pollution events were linked to transportation.

Contamination Levels

Since the early 1980s, MDC has conducted contaminant surveys on fish and mussels. Statewide fish contaminant sampling was initiated after suspected contaminant problems were discovered by the U.S. EPA. Based on fish sampling and analysis performed by Department of Conservation, the Department of Health issues annual health advisories regarding the safety of eating fish harvested from Missouri streams and impoundments. The 1999 Missouri Department of Health Fish Advisory reports that fish, i.e., catfish, bluegill, crappie, and walleye taken from the Bourbeuse River are safe for human consumption.

From 1980-1983, MDC fishery biologists collected and analyzed mussels and fish from the Bourbeuse River watershed to detect mean heavy metal concentrations (mg/kg) in the soft tissue of freshwater mussels and edible tissue of fish (Table 12). These data show the variation among fish species, especially suckers, having higher concentrations of heavy metals than centrarchid species. Also, mussels accumulate more heavy metals than fish, demonstrating that mussels are useful water quality indicators.

Table 10. Selected water quality data for the Bourbeuse River Watershed at Lat. 38E25'55", Long. 91E01'11, Union, Franklin County, Hydrologic Unit #07140103, Gage station #07016400 for water years 1964, 1973, 1984, 1996 (USGS 1963-96; MDNR WQ Code of Regulations 10 CSR 20.7).

	State Standard of Uses			Water Year				
Parameter	I	III	VI	VII	1964	1973	1984	1996
	32.2º N	Iax ¹						
Water Temperture (°C)	28.9º N	Iax ²			0-27E	0-27.5E	0.5-27E	2.0-27.5E
Specific Conductance (us/cm)					165-360	131-310	76-295	152-340
O ₂ , Dissolved (mg/l)	51,62				6-12.9	6-10.9	4.4-14.2	6.7-13.2
рН	3*	,	,	<i>Y</i>	7.2-8.4	7.3-8.1	7.3-8.0	7.3-8.6
Hardness, Total (mg/l CaCO ₃)					62-180	54-140	84-150	71-120
Calcium, Dissolved (mg/l as Ca)					14-36	11-28	17-29	14-26
Magnesium, Dissolved (mg/l as Mg)					6.6-23	6.4-17	11-19	8.8-17
Fluoride, Dissolved (mg/l as Fl)		4		4		0.1-0.2	<0.1-0.6	<0.1-0.1
Sulfate, Dissolved (mg/l as SO ₄)		250			13-28	14-21	14-24	13-20
Nitrogen, Total Ammonia (mg/l as NH ₄)						<0.01-0.2	0.0-0.1	0.0-0.1
Nitrate-N (mg/l N)		10		10		0.1-0.4	0.0-1.0	<0.02-0.5
Phosphorus, Total P (mg/l as PO ₄)						0.0-0.2	0.0-0.4	<0.02-0.1
Coliform, Fecal (colonies/100ml)			200				6-1100	7-400
Streptococci, Fecal (colonies/100ml)								1-2000
Iron Dissolved (mg/l FE)						50-350	15-120	20-180

I: Protection of aquatic life.

III: Drinking water supply.

VI: Whole-body-contact recreation.

VII: Groundwater.

¹For warm-water fisheries.

²For cold-water fisheries.

³H₂O contaminants should not cause pH to fall out of 6.5-9.0 range.

Table 11. Summary of pollution investigations on streams of the Bourbeuse River Watershed (USGS #07140103) sorted by year within county from 1990 to 1995 (Missouri Department of Conservation Environmental Services and East Central Region files).

Date	County	Subwatershed	Stream Name	DischargeSubstance
02-01-94	Crawford	090-007	Winsel Creek	Rhodamine-WT dye
07-22-94	Crawford	090-007	Winsel Creek	Diesel Fuel, other petroleum
09-08-94	Crawford	090-003	Little Bourbeuse River	Ammonia nitrate, diesel fuel
01-27-92	Franklin	*	Bourbeuse River, unname tributary	Gasoline/oil
01-28-91	Franklin	*	Bourbeuse River, tributary to	Spices
05-24-95	Franklin	100-002	Flat Creek	Chlorine

^{*} Not Given

In 1986, the Conservation Department sampled several sites throughout Missouri for chlordane levels in the fillets of game fish. Samples of catfish species and flathead catfish in Indian Lake, an impoundment near Cuba, contained concentrations of chlordane over the U.S. FDA action level of 0.3 mg/kg (McGrath 1988). Chlordane concentrations in catfish species and flathead catfish were 0.478 and 1.238 mg/kg, respectively. Bluegill sunfish and largemouth bass were well below the action level. Catfish species (bottom feeders) have different feeding strategies than centrarchid species (mid-column feeders), explaining the differences in contaminant concentration between species. Carried to streams and lakes by rainfall runoff, chlordane accumulates in the sediments, and a bottom feeder can easily ingest large quantities of sediment during feeding. Also, age and size of fish can influence the bioaccumulation of toxins into the muscle tissue. Many pesticides like chlordane are lipophilic (Burkley, Kellogg, and Shannon 1976). In many studies, pesticide levels were found to vary with fish size, but Burkley et al. (1976) found size is not as important as the factors that vary with fish size, such as fat content and metabolic rate. This fact suggests that season and water temperature may be an important determinant in pesticide contaminant levels. Fish contaminant samples should be collected during periods (early fall) when fat content and metabolic rate are at their highest to assure that contaminant values are at the maximum possible.

During 1994, MDC biologists collected fish contaminant samples from 30 sites in Missouri. Only one sample at Foxboro Lake was taken from the Bourbeuse River watershed (Buchanan 1995). Chlordane levels were in the safe zone for the largemouth bass sampled from this lake in Franklin County. Statewide, chlordane and lead were the only two toxins that were found in fish in 1994 that exceeded U.S. FDA action levels for human consumption. The World Health Organization's maximum safe level for lead is 0.3 mg/kg.

The 1997 fish contaminant sampling on the Bourbeuse River at Union included 30 fillets of carp, 8 fillets of bass species, and 15 fillets of redhorse species. Chlordane levels were below action levels for all fish sampled (Table 12). Chlordane found within filleted fish composites were 0.045 mg/kg for carp and 0.089 mg/kg for redhorse species. Lead and cadmium levels were below action levels for all fish species sampled.

Water Use

Water use refers to water used for any purpose (MDNR 1986). All classified streams within the Bourbeuse River watershed are designated as suitable for warm-water aquatic life protection and fishing (AQL), and livestock and wildlife watering (LWW). The warm-water aquatic life protection is an important and complex use. Fish need water and Missourians enjoy fishing. Water provides habitat for fish, and that habitat has various components such as in-stream flows, water depth, cover, and streambed substrates. Habitat for fish is a delicate balance that must be maintained if fish species are not to be lost (see Habitat Section). Reduction in number of fish species can be an indicator of a failing ecosystem. Endangered aquatic species could be eliminated, should habitat quality become degraded. Livestock water use is defined by the USGS as water used in the production of livestock, such as cattle, poultry, and hogs. No figures are available for the watershed as a whole, but Franklin County uses between 176-225 million gallons per day for livestock water use. One can estimate water use by multiplying the selected livestock populations (U.S. Bureau of the Census) by the coefficients 8.8 gallons per day per animal (G.P.D.) for cattle, 27.4 G.P.D. for milk cows, 0.7 G.P.D. for sheep and lambs, and 2.6 G.P.D. for hogs and pigs (DuCharme and Miller 1996). Livestock represent most of the agricultural production in the Bourbeuse River watershed (MASS 1995).

Table 12. Mean heavy metal concentrations (mg/kg) in the soft tissue of freshwater mussels and edible fish tissue in the Bourbeuse River watershed collected by MDC, 1980-83. ¹Collected by MDC in 1997.

Water Body	Location	County	Species	N	Lead	Cadmium
Bourbeuse River	Union	Franklin	Pocketbook	8	0.12	.090
Bourbeuse River	Reiker Ford Access	Franklin	Northern hog sucker	10	0.04	<.030
Bourbeuse River	Reiker Ford Access	Franklin	Black redhorse	1	.009	<.030
Bourbeuse River	Reiker Ford Access	Franklin	Smallmouth bass	6	.004	
Bourbeuse River	Reiker Ford Access	Franklin	Longear sunfish	6	<.005	
Bourbeuse ¹ River	Union Access	Franklin	Carp	-	< .010	.0031
Bourbeuse ¹ River	Union Access	Franklin	Bass species	-	.010	.0015
Bourbeuse ¹ River	Union Access	Franklin	Redhorse species	-	<.010	.0037

FDA and the World Health Organization (WHO) have identified action levels for lead as 0.3 mg/kg, cadmium as not determined, mercury as 1 mg/kg, and PCBs as 1 mg/kg.

Brush Creek in Crawford County has, besides the designation for AQL and LWW, a designation for whole-body contact recreation from the mouth to the dam at Indian Lake (MDNR 1994). Designated uses for the Bourbeuse River from the mouth to T39N, 6W, Sec 4 are irrigation, LWW, AQL, cool-water fishery, whole-body contact and recreation, boating and canoeing, and drinking-water supply. This designation covers 132 miles, leaving the remaining nine miles as LWW, AQL, and cool-water fisheries. The Bourbeuse River has no surface-water withdrawals for public drinking water supply (MDNR 1984, 1996). The MDNR has limited data to quantify watershed irrigation water use; however, six percent of the irrigation in Missouri is from surface-water withdrawals (DuCharme and Miller 1996).

Point Source Pollution

Point source pollution is permitted through the NPDES (National Pollution Discharge Elimination System). Some of the major sewage and water treatment plants with discharge greater than 0.100 MGD in the Bourbeuse River watershed (Table 13) include Belle, Bourbon, Cuba, Gerald, Leasburg, Owensville, St. Clair, St. James, Sullivan, and Union. The ten facilities each affect 1-2 miles of receiving stream reach (MDNR 1984, 1996). Because it lacks proper operation and maintenance, the Cuba Waste Water Facility continues to impact Pleasant Valley Creek with heavy algal growth and sludge--the facility. The Bourbon Waste Water Treatment Facility has similar maladies, affecting receiving waters with sludge, turbidity, and discoloration (MDNR 1996). Overall, major treatment facilities are functioning properly, while periodic surveys are required by Missouri Water Pollution Control Program. The MDNR Water Quality Basin Plan lists 78 non-public waste-water treatment facilities and 17 public treatment facilities in the Bourbeuse River watershed. In the plan, flow rate, receiving location, and EPA river reach code are listed for each facility. The largest listed contributor of a non-public pollution source is Kingsford Products, discharging to the Dry Fork.

Two decades ago, Missouri Department of Conservation biologists noted that portions of the Bourbeuse River and several of its permanent tributaries (Red Oak Creek, Happy Sock Creek, Pin Oak Creek) were influenced by point source pollutants (Duchrow 1978). Excessive plant growth was noted by MDC biologists that indicated nutrient enrichment was the cause. Specific pollution sources were not identified in the 1978 report. Severity of the problems were also omitted; however, Happy Sock and Pin Oak are small tributaries to Bourbeuse River that flow through urbanized areas near Union and I-44.

Concentrated Animal Feed Operations (CAFOs)

Twelve animal feedlots are found within the Bourbeuse River that require permitting through the Missouri Department of Natural Resources (Table 14). The MDNR's permitting program is voluntary for farm operations with less than 300 animal units. This means that many farms are not in the database. In addition, permitted operations listed in the database may no longer be in operation because MDNR may not have been notified of the change (Scott Tackett, MDNR, personal communication). Several farms in Bourbeuse River watershed have high concentrations of swine, poultry, or cattle adjacent to streams, and during low flow they could impair water quality.

Non-point Source Pollution

Runoff from farms, forest operations, residential septic tanks, and impervious surfaces in urban areas are considered non-point source pollutants. Annual runoff at the High Gate Gage Station on the Bourbeuse has averaged 13.77 inches from 1965-1996. Union Gage Station annual runoff has averaged 11.39 inches

from 1921-1996. The MDNR Bourbeuse River Water Quality Basin Plan (1984, 1996) lists three sites as potential non-point pollution sources. These sites are a hog feeding operation in Maries County, a landfill in Crawford County, and a landfill in Franklin County.

In a report by Duchrow (1978) he noted non-point sources existed near Melody Lake and another several miles upstream from Noser Mill. No specifics were mentioned, but excessive plant growth in the observation could have been cause by agricultural sources.

Agricultural pollution comes in several forms: silt from erosion, chemical fertilizers, pesticides, and organic wastes from livestock. Presently, cultivated cropland represents nearly 4% of the land use in the watershed, and uncultivated cropland represents nearly 13% of the land use. Although this appears to be a small percentage, the majority of the cultivation takes place within the floodplain of streams. The negative impacts of crop cultivation are transmitted directly to the stream, if stream corridor is poor. The good news is that based on contaminant sampling for pesticide bioaccumulation in fish, pesticides are at relatively safe levels for humans. However, organic wastes from livestock continue to contribute to the excessive algal production in watershed streams. For several decades, water quality and nutrient supply has been altered by agricultural activities. Agencies continue to work with farmers to change this condition.

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Table 13. Major sewage and water treatment plants (flow > 0.100 MGD) in the Bourbeuse River Watershed (MDNR 1996).

Facility	Flow ¹	Receiving Stream	County	Watershed Code ²
Belle WWTF	0.148	Klein Branch	Maries	040-001
Bourbon WWTF	0.125	Trib. of Boone Creek	Crawford	090-006
Cuba Municipal WWF	0.520	Pleasant Valley Creek	Crawford	090-002
Gerald E Lagoon	0.105	Big Creek	Franklin	090-008
Leasburg WWTF	0.064	Little Bourbeuse River	Crawford	090-003
Owensville WWTF	0.288	Trib. of Red Oak Creek	Gasconade	090-005
St. Clair WWTF	0.657	Happy Sock Creek	Franklin	100-001
St. James STP	0.615	Robinson Creek	Phelps	020-001
Sullivan WWTP	0.800	Winsel Creek	Franklin	090-007
Union WWTF	0.800	Bourbeuse River	Franklin	100-002

¹ Million gallons per day (MGD)

² Hydrologic unit code

Table 14. Location of permitted animal waste facilities within the Bourbouse River watershed as of October 1, 1999 (MDNR 1999). All classified operations are included.

Operation Type	Amount of Units	LocationTwn-Rng-Sec*	County
A hog operation	3,200	41-5W-SENW 30	Gasconade
A hog operation	650	41-5W-SWSNE 1	Gasconade
A hog operation	500	39-7W-NWSE 4	Maries
A hog operation	4,000	40-08W-NENW 26	Maries
A hog operation	600	39-8W-SWSW 24	Maries
A hog operation	3,200	40-7W-NENW 04	Maries
A hog operation	16	41-7W-NENE 22	Maries
A hog operation	5,760	39-7W-SNNW 2	Maries
A hog operation	20	42-1W-SESE 19	Franklin
A dairy milking or cow	150	43-3W-NENE 9	Franklin
A hog operation	20	43-1E-SWSW 18	Franklin
A hog operation	24	42-2-SWNE 28	Franklin

^{*} Section is from smallest to largest